Chapter 4 Homework

1. Calculate the angular velocity for a geosynchronous orbit, in radians/second.

$$w = \frac{2p}{86400} = 7.27 \times 10^{-5} \; \tfrac{radians}{second}$$

2. Calculate the period for a circular orbit at an altitude of 1 earth radius.
Lots of approaches - here is one.

$$v = \sqrt{\frac{g_o}{r}} R_{Earth} = \sqrt{\frac{g_o}{2R_{Earth}}} R_{Earth} = \sqrt{\frac{g_o R_{Earth}}{2}} = \sqrt{4.9 \bullet 6.38 \times 10^6} = 5591 \tfrac{meters}{second}$$

$$period = t = \frac{2p \; r}{v} = \frac{2p \bullet 2R_{Earth}}{\sqrt{\frac{g_o}{2R_{Earth}}} R_{Earth}} = 2p\sqrt{\frac{8R_{Earth}}{g_o}} = 14339.1 \text{ seconds or 239 minutes}$$
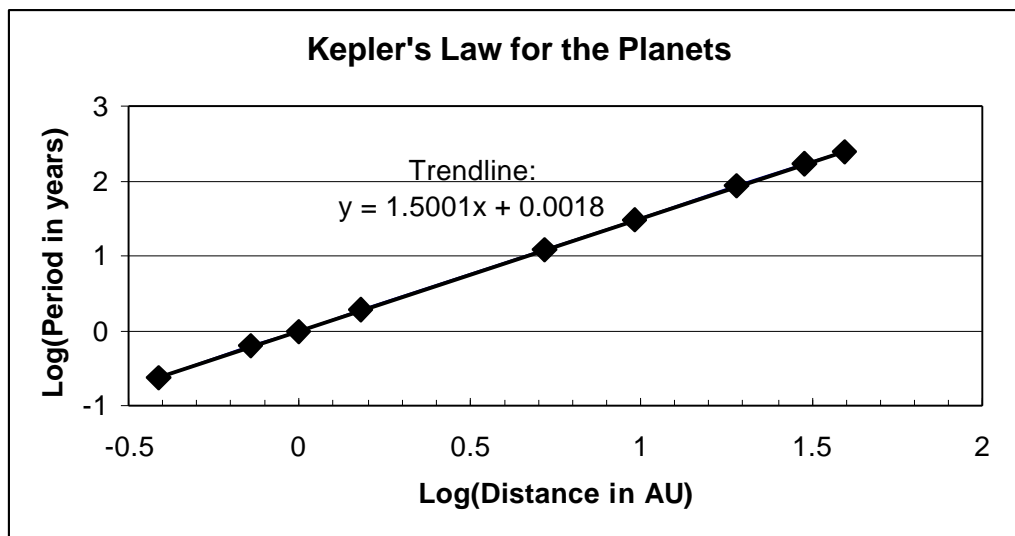
3. Calculate the period for a circular orbit at the surface of the earth. What is the velocity?
This is a "Herget" orbit, and is considered undesirable for a satellite.

$$v = \sqrt{\frac{g_o}{r}} R_{Earth} = \sqrt{\frac{g_o}{R_{Earth}}} R_{Earth} = \sqrt{g_o R_{Earth}} = \sqrt{9.8 \bullet 6.38 \times 10^6} = 7907 \tfrac{meters}{second}$$

$$distance = 2p \bullet 6.38 \times 10^6 = 4.009 \times 10^7 \text{ m}$$

$$period = \frac{4.009 \times 10^7}{7907} = 5069 \text{ seconds or 84.5 minutes}$$

4. Look up the orbits for the 9 planets, and plot the period vs. the semi-major axis. Do they obey Kepler's third law? Best done by using a log-log plot. Even better, plot the two-thirds root of the period vs the semi-major axis (or mean radius).

Kepler's Law for the Planets

Trendline:
y = 1.5001x + 0.0018

Log(Period in years) vs Log(Distance in AU)

planet	distance to sun in au	period of revolution in years
mercury	0.386	0.241
venus	0.720	0.615
earth	1.000	1
mars	1.520	1.88
jupiter	5.187	11.9
saturn	9.533	29.5
uranus	19.133	84
neptune	30.000	165
pluto	39.333	248

5. Derive the radius of orbit for a geosynchronous orbit.